Reprinted from HORTSCIENCE, Vol. 18(5), October 1983
A publication of the American Society for Horticultural Science, Alexandria, Virginia

HortScience 18(5):732–734. 1983.

Management Practices for Fresh-market Tomato Production in the Southeastern Coastal Plain

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Additional index words. *Lycopersicon esculentum*, trickle irrigation, soil water management, mulch

Abstract. **Yields of tomato (*Lycopersicon esculentum* Mill.) were highest with trickle irrigation, mulching, and staking, but the importance of the individual management components was dependent upon seasonal weather pattern. In 1979, plants that were staked, but not irrigated, produced 78 MT/ha of marketable fruit. Irrigating the staked plants increased yields to 94 MT/ha and to 97 MT/ha if the beds were mulched with black polyethylene. Without staking the plants in 1979, neither trickle irrigation nor mulching influenced fruit yield, which averaged only 45 MT/ha. In 1980, because of a prolonged drought, trickle irrigation increased yields from 33 to 65 MT/ha, mulching increased yields from 42 to 58 MT/ha, but staking did not significantly influence yield. Seasonal water balances suggested that tomato grown on a Norfolk loamy sand should be irrigated before the soil water-tension at the 30-cm depth in the center of the bed exceeds 25 kPa.**

Economic pressure in the Southeastern Coastal Plain has increased interest in the incorporation of high-value vegetable crops such as tomato into production systems. The efficiency of Florida's commercial tomato industry was improved by converting from ground to staked culture, soil mulching with polyethylene film, and irrigation (5). Polyethylene mulch improved the soil moisture condition and N efficiency (8) and increased the quantity of product per unit of energy (4).

Although irrigation methods had little effect on tomato yield (3), trickle irrigation required less than half the water required for furrow or sprinkler irrigation. Trickle irrigation has increased in the Southeastern Coastal Plain, but has been implicated in a nonbacterial "soft-fruit" problem by growers. In this study, we studied the effects of mulching, staking, and trickle irrigation on yield and storage quality of fresh-market tomatoes.

'Flora-Dade' tomatoes were grown on a Norfolk (Typic Paleudult) loamy sand in South Carolina. Two experiments with 3 treatments: 1) polyethylene mulch with trickle irrigation, 2) bare soil with trickle irrigation, and 3) bare soil without irrigation were conducted in 1979. All plants in expt. 1 were staked with treatments replicated 4 times; in expt. 2, plants were not staked and treatments were replicated twice. A factorial design was used in 1980 to evaluate 8 treatments consisting of all combinations of the following factors: 1) mulched and nonmulched, 2) staked and nonstaked, and 3) irrigated and nonirrigated. Treatments were replicated 4 times.

The soil was limed to raise the pH to 6.5, subsoiled to a depth of 50 cm, and disked

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prior to forming rough beds on 2-m centers. Fertilizer was applied at 140, 88, 166, and 0.7 kg/ha of N, P, K, and B, respectively, and incorporated prior to fumigating with 336 kg/ha of a 67/33% mixture of Bromomethane/Trichloronitromethane (methyl bromide/chloropicrin). The beds were pressed and covered with 150-cm wide, 0.04-mm-thick black polyethylene mulch. One twin-wall trickle irrigation tube with outlets every 30 cm and a discharge rate of 65 ml $min^{-1}m^{-1}$ was placed at a depth of 5 cm beneath the mulch about 15 cm from the center of the bed.

Tomato seedlings were transplanted 46 cm apart on May 3, 1979, and March 25, 1980. Plants were pruned and sprayed with 0,0-diethyl 0-(2-isopropyl-4-methyl-6-pyrimidinyl) phosphorothioate (Diazinon) or 1-naphthyl N-methylcarbamate (Carbaryl) as needed. Fungicides were not required.

Soil water-tensions at the 30- and 60-cm depths were monitored with vacuum-gauged tensiometers placed between plants in the center of the beds. Irrigation was applied when soil water-tensions at the 30-cm depth exceeded 25 kPa (centibars). On-site temperature, wind, net radiation, rainfall, and screen-covered pan evaporation were measured continuously. Potential evapotranspiration (PET) was estimated from the screen-covered pan evaporation data (1) and from the net radiation data (7).

Mature-green, breaker, and ripe fruit were harvested 4 times. To evaluate storage quality, internal fruit firmness was measured by placing 6 mature-green fruit in a constant temperature room at 20°C for 12–15 days, slicing the fruit in half, and determining the resistance of the flesh to crushing with a penetrometer.

In expt. 1 where plants were staked, trickle irrigation with or without mulching increased fruit yield 19 or 16 MT/ha, respectively, over those neither irrigated nor mulched (Table 1). In expt. 2 where plants were not staked, there were no significant differences between treatments, but the average marketable fruit yield was only 45 MT/ha. Trickle irrigation in expt. 3 increased marketable fruit yield from 33 to 65 MT/ha. Mulching with polyethylene increased yield from 42 to 58 MT/ha, but staking had no significant effect. Trickle irrigation significantly improved fruit quality (64% of the tomato fruit graded U.S. #1 without irrigation vs. 71% with irrigation). Interactions between irrigation, mulching, and staking factors were not significant.

The 3 experiments cannot be compared statistically because of differences in experimental design, but in both years, tomatoes that were staked, mulched, and irrigated produced the highest yields, 97 MT/ha in 1979 and 74 MT/ha in 1980.

Rainfall in the tomato season totaled 31 cm in 1979 and 27 cm in 1980. Distribution, however, was more uniform in 1979 because the longest periods without significant rainfall were only 12 days and 16 days (Fig. 1) compared to a 28-day period in 1980 (Fig. 2). Without applying irrigation water during these periods of drought, soil water-tensions at the 30- and 60-cm depths in the center of the tomato beds exceeded 50 kPa in 1979 and 80 kPa in 1980 (Fig. 1 and 2). Water-retention curves for typical Paleudult soils in the South Carolina Coastal Plain (2) show that most of the available soil water is released before soil water-tensions exceed 100 kPa. Irrigated tomatoes yielded twice as much as nonirrigated tomatoes in 1980 because of the severe drought.

A total of 14 cm of water was applied to irrigated tomatoes in 1979 and 25 cm in 1980. By managing irrigation with tensiometers placed in the center of the tomato beds, available water in the tomato root zone could be maintained between 50% and 100% of field capacity. Fig. 1 and 2 show that this irri-

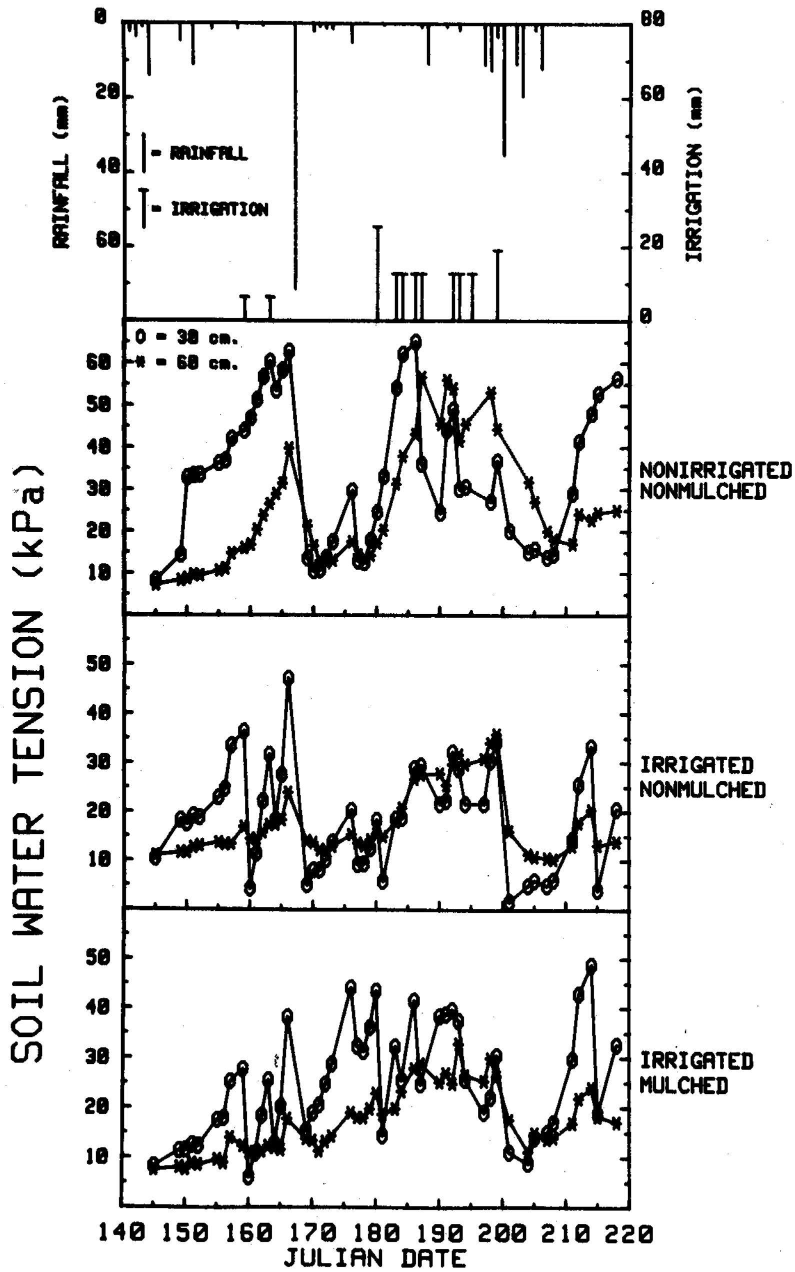

Fig. 1. Soil water-tensions in tomato beds as influenced by rainfall, irrigation, and mulching in 1979.

Table 1. Total fresh-market yield as influenced by management practice.

Treatment	Marketable yield (MT/ha)
Expt. 1, staked (1979)	
Nonmulched, nonirrigated	78.5 b[z]
Nonmulched, irrigated	94.2 a
Mulched, irrigated	97.3 a
Expt. 2, nonstaked (1979)	
Nonmulched, nonirrigated	40.0 a
Nonmulched, irrigated	41.4 a
Mulched, irrigated	53.8 a
Expt. 3 (1980)	
Irrigated	65.2 a
Nonirrigated	32.8 b
Mulched	57.6 a
Nonmulched	41.9 b
Staked	48.9 a
Nonstaked	52.3 a

[z]Mean separations within experiments by Duncan's multiple range test, 5% level.

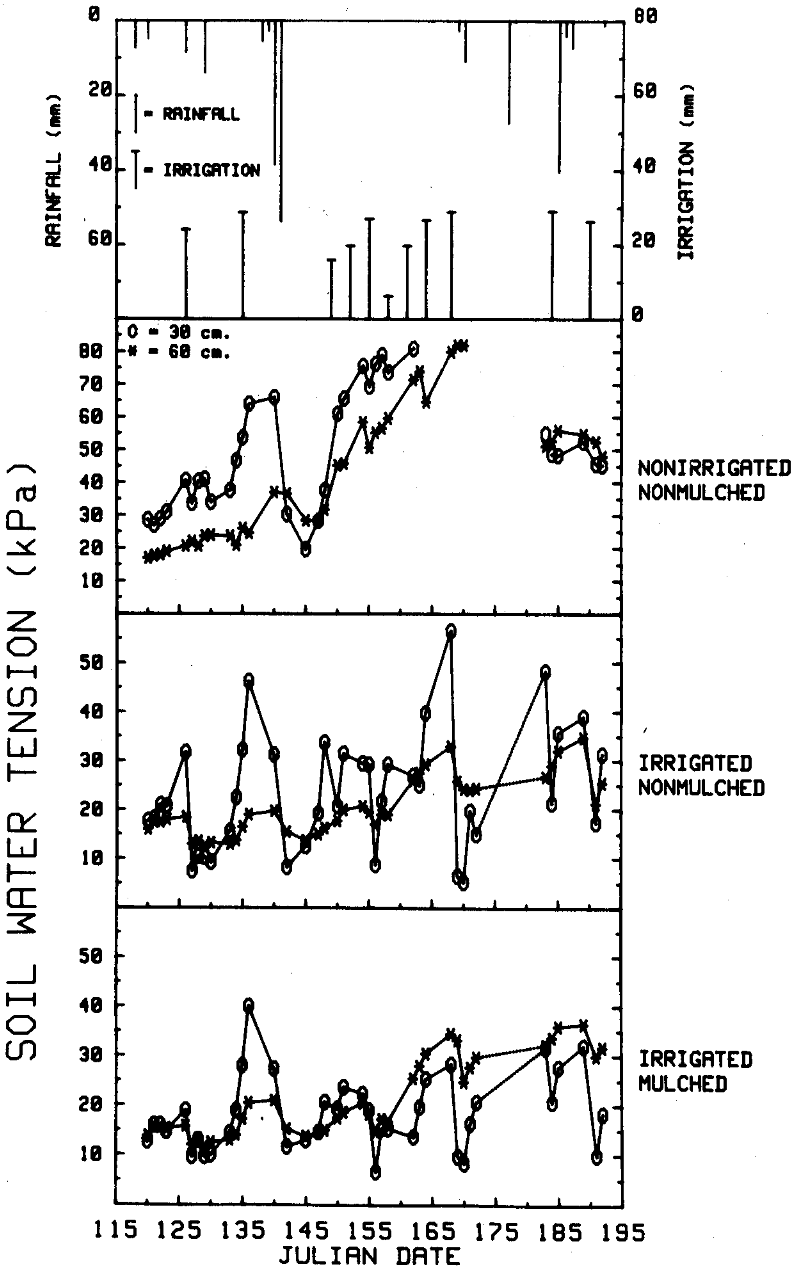

Fig. 2. Soil water-tensions in tomato beds as influenced by rainfall, irrigation, and mulching in 1980.

gation scheduling technique generally kept soil water-tensions below 50 kPa at the 30-cm depth and below 40 kPa at the 60-cm depth.

Mulching irrigated tomatoes influenced soil water-tensions at the 30-cm depth in opposite ways in 1979 and 1980. Soil water-tensions in 1979 in the irrigated but nonmulched plots were generally lower than polyethylene-mulched plots (Fig. 1), because rain-water ran off the mulch without influencing the tensiometers. In 1980, however, soil water-tensions in irrigated but nonmulched plots were greater than irrigated and mulched plots (Fig. 2).

Predicted potential evapotranspiration using either screen-covered pan data or net-radiation data was similar within a growing season. Water demand by the irrigated tomato crop exceeded water supplied by about 2 cm each year. Tensiometer data in Fig. 1 and 2 verify that evapotranspiration demand was slightly greater than the water supplied because soil water-tensions showed a slight net increase during the growing season.

These results suggest that when tensiometers placed in the center of the tomato beds are used to schedule irrigation on a Norfolk loamy sand, water should be applied before soil water-tensions at 30 cm exceed 25 kPa. Careful water management, however, is essential to prevent over irrigation of tomatoes grown on this type of soil. In a greenhouse experiment, when excess water was applied to tomato plants growing in Norfolk loamy sand, internal firmness of stored mature-green tomato fruit was reduced, rate of fruit maturation was increased, and "soft-fruit" symptoms similar to those described by commercial tomato producers were observed (9). There were no "soft-fruit" symptoms or differences in fruit firmness (data not shown) caused by trickle irrigation, mulching, or staking in these 3 field experiments.

Plant tissue analyses data (not presented) showed that N and other nutrients were within the ranges reported by Geraldson et al. (6) and that fertilizer applications were adequate. Movement of NO_3^-–N to 90 cm was monitored, but there were no differences between mulched and nonmulched treatments because water management and rainfall patterns did not cause significant leaching losses.

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